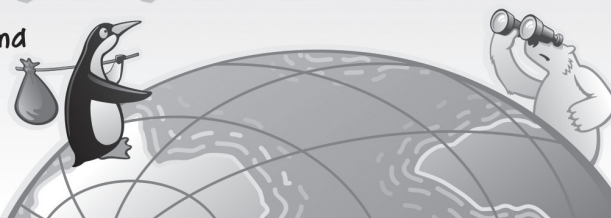
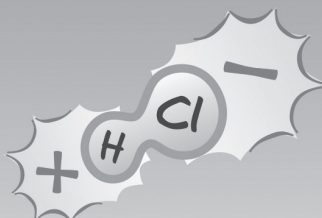


# The BARE ESSENTIALS of POLARITY

You don't have to go to the ends of the earth to find polar molecules. They're all over the place. A polar molecule is just a molecule with a difference in electrical charge between two ends.



Polarity in molecules is caused by differences in electronegativity between atoms. Electronegativity describes the ability of an atom to attract bonding electrons toward itself.



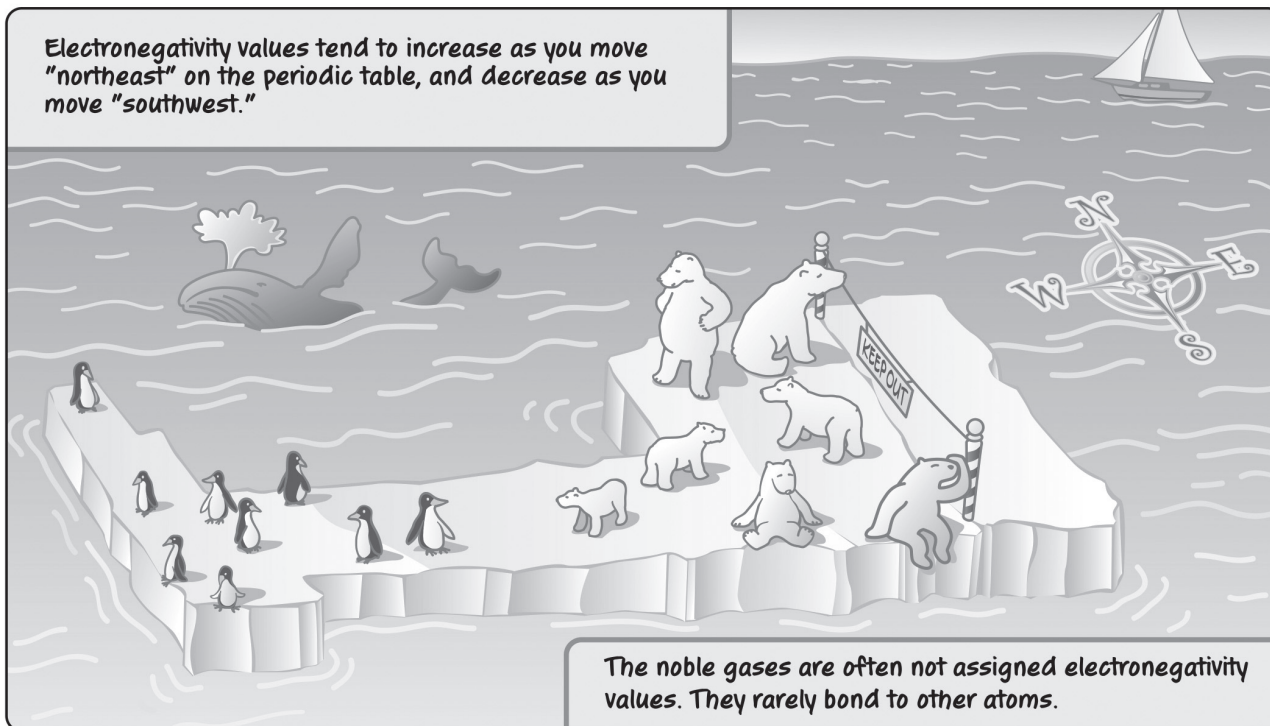
Bonded pair of electrons

HEY!

Chlorine is more electronegative than hydrogen. So the bonded pair of electrons in HCl spends more time near chlorine.



Electronegativity values tend to increase as you move "northeast" on the periodic table, and decrease as you move "southwest."



The noble gases are often not assigned electronegativity values. They rarely bond to other atoms.

When two atoms with different electronegativity values bond, the bonding electrons spend more time around the more electronegative atom, creating a PARTIAL NEGATIVE CHARGE on that atom. The other atom then has a PARTIAL POSITIVE CHARGE, and the bond is polar.



When atoms with equal electronegativity values bond, they form nonpolar bonds. The electron-attracting strength of each atom is the same.

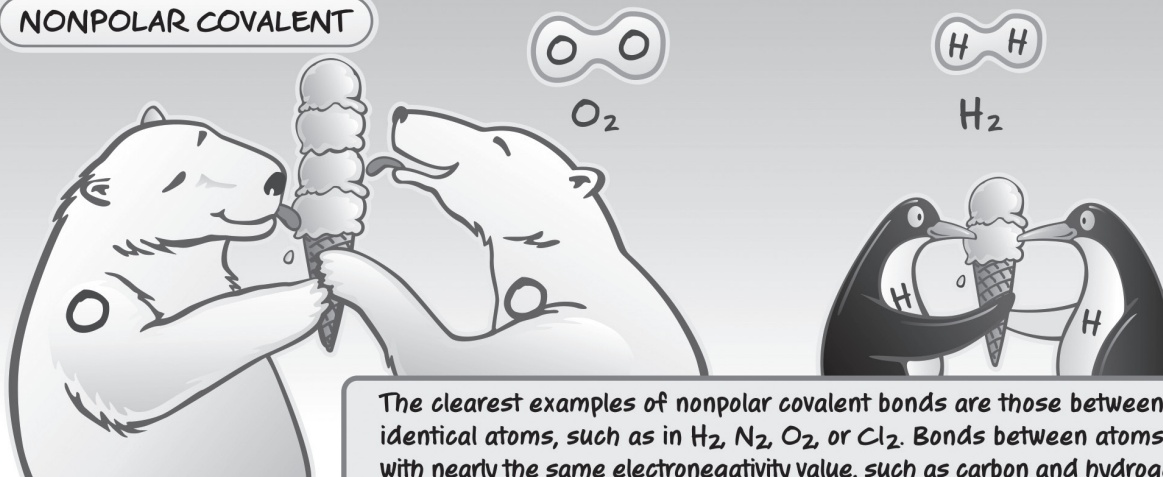


However, if the electronegativities of two bonded atoms are different, then their bond will be polarized—maybe a little...



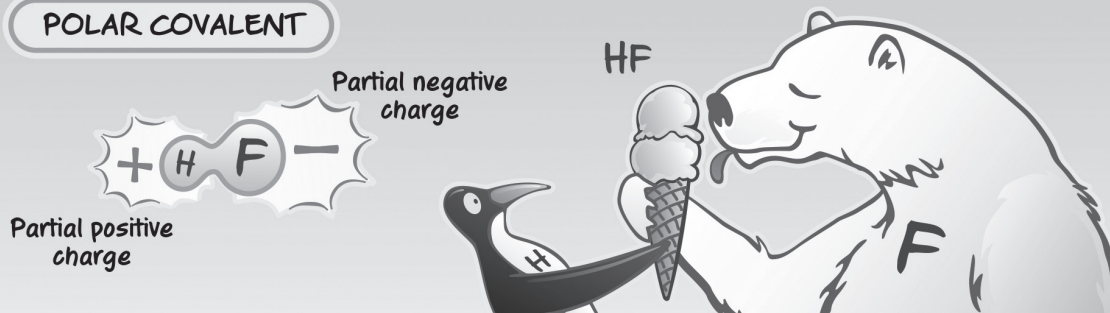
Because the elements have such varying electronegativities and can bond in many different combinations, there is really a continuum of polarity in bonding. We can break the continuum down into three categories.

### NONPOLAR COVALENT



The clearest examples of nonpolar covalent bonds are those between identical atoms, such as in  $H_2$ ,  $N_2$ ,  $O_2$ , or  $Cl_2$ . Bonds between atoms with nearly the same electronegativity value, such as carbon and hydrogen, can also be considered nonpolar.

### POLAR COVALENT



In a polar covalent bond, two atoms share bonded pairs of electrons somewhat unequally. The electrons are more attracted to one atom than the other. Examples include bonds between carbon and oxygen atoms, or between hydrogen and fluorine atoms.

### IONIC



A large difference in electronegativity results in the winner-take-all situation of ionic bonding. The more electronegative atom takes the bonding electrons and becomes a negative ion, while the other atom becomes a positive ion. The opposite charges on the ions attract each other.



Polar bonds between atoms create dipoles. The word dipole can refer to (1) the polarity of an individual polar bond between atoms, (2) the net polarity of an individual polar molecule that may have several polar covalent bonds within it, and (3) the polar molecule itself.

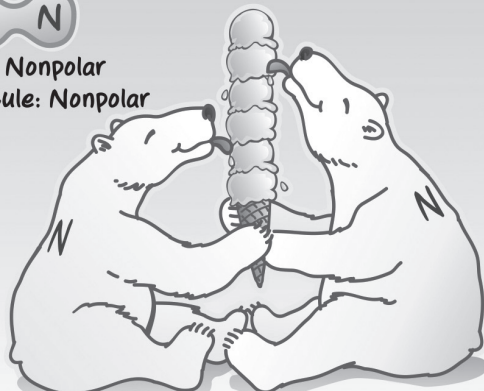


Confusing? Here are some examples:

An  $N_2$  molecule isn't a dipole and it doesn't have any dipoles.



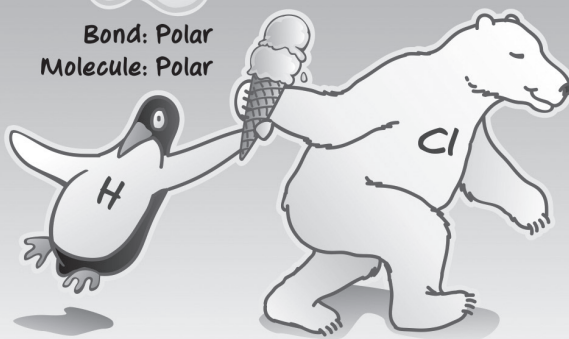
Bond: Nonpolar  
Molecule: Nonpolar



$HCl$  has a dipole and it is a dipole.



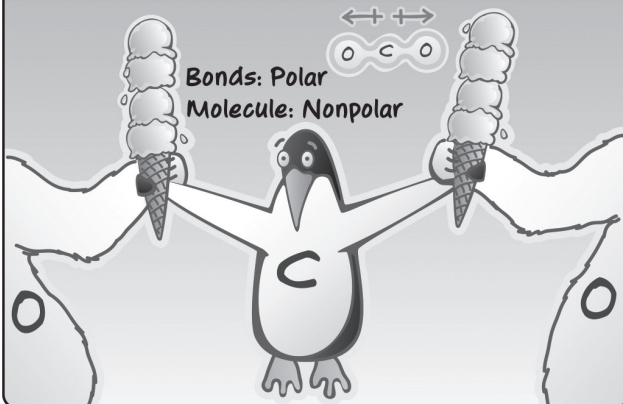
Bond: Polar  
Molecule: Polar



$CO_2$  has two dipoles but the  $CO_2$  molecule itself is not a dipole. Its polar bonds balance each other out and make the molecule nonpolar overall.

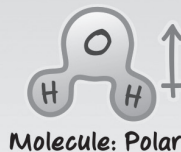


Bonds: Polar  
Molecule: Nonpolar

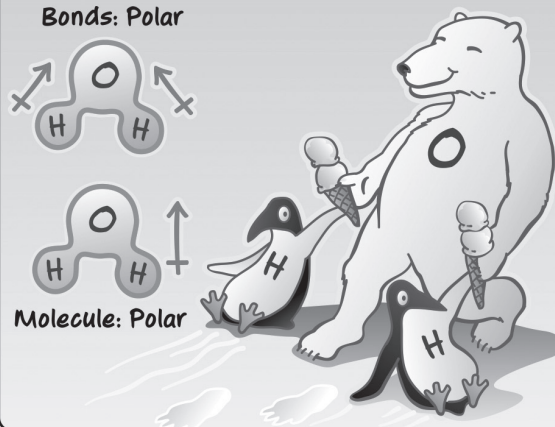


$H_2O$  has two dipoles. Because of its bent shape, it also has a dipole in the sense of an overall polarity.

Bonds: Polar



Molecule: Polar



The polarity of molecules can affect many of their other properties, such as their solubility, their boiling and melting points, and their odor.

